Drosophila Activity Monitoring System
User's Guide

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System Operation

The TriKinetics Drosophila Activity Monitoring System consists of one or more Activity Monitors, a Power Supply Interface Unit and Power Supply, and a host Macintosh or Windows PC for data collection. Each monitor uses an onboard microprocessor to independently detect and count activity events, and at periodic intervals to upload the activity totals to the host computer.

The monitors are connected to the Power Supply Interface Unit by a network of conventional 4-wire telephone cables which supply operating power and lines for data transmission. Monitors may be plugged and unplugged from the network at will without disturbing the activity of other monitors.

Data Collection

At periodic intervals, ranging from 1 second to 60 minutes, the DAMSystem program in the host computer transmits a command to all monitors to simultaneously 'freeze' their current count totals. The monitors set aside these 'frozen' counts, reset the totals to zero, and begin counting again for the next measurement period.

Meanwhile, the host begins a sequence of requests from each monitor in turn (by address number) to transmit its 'frozen' counts to the computer for storage and later output. This data collection or 'reading' sequence requires about 2/3 second per monitor, placing a lower limit on the reading interval if multiple monitors are used.

Data Storage

The DAMSystem3 program stores the retrieved monitor data in a folder on the hard drive which is automatically created: DAMSystem3Data. Individual text files for each monitor accumulate successive readings for as long as the program operates, and these files may grow without limit to the capacity of the disk drive.

At the conclusion of an experiment, perhaps covering several weeks of continuous data collection, these monitor text files containing the captured data should be moved out of the DAMSystem3Data folder for processing and analysis. The DAMSystem3 program will create new files as necessary to store additional data as it is collected.

File Scan

Prior to processing and analysis, the data files should be scanned using the DAMFileScan program to insure that the data records are complete, with no gaps or duplicate readings.

This program produces a new set of output files from the input monitor files, and in addition to cleanup, allows for the extraction of data within a specified date/time range, as well as compression to a longer bin length if desired. Thus, for example, activity data collected at 1-minute intervals may be converted to 30-minute intervals for analysis or plotting purposes.

The program also allows input monitor files to be converted to legacy Channel files (as produced by the earlier DAMSystem2 program) for compatibility with existing analysis procedures.

Data Analysis

Outputs from the DAMSystem3/DAMFileScan software suite are essentially columns of numbers, with each entry corresponding to an activity total recorded by a single monitoring channel over a short period of time (collection bin.) These individual columns or files may be plotted or analyzed in various ways, including import into Excel, ClockLab, FlyTools, or other software.

Installation

A complete monitoring system includes the following components. All are available from TriKinetics, save the computer:

1. Macintosh or Windows PC with available USB port
2. DAMSystem3 Data Acquisition Software
3. Power Supply Interface Unit with USB cable
4. DC Power Supply with line cord (9 volt output)
5. Activity Monitor(s)
6. Telephone-type cables, couplers, and 5-way splitters
7. Light Controller (optional)

Software Installation

The DAMSystem3 application is available for download from www.trikinetics.com. Choose the correct version for your host computer and operating system:

DAMSystem3 for Windows (98-XP)

DAMSystem3 for Macintosh OSX

Save the compressed file to the hard drive, and UnZip or UnStuff it; then move the program to any convenient folder and launch it.

USB Drivers

The Power Supply Interface Unit (PSIU) uses a Universal Serial Bus (USB) hardware connection to the host computer, and is activated by a one-time installation of unique USB driver software for the PSIU. These drivers simply synthesize in software a serial data link between the DAMSystem program and the PSIU/activity monitors, which in the case of the PC will be a COM port, and in the Macintosh a simple serial port.

The USB drivers are available for download from the TriKinetics web site, and must be installed into the host computer prior to data collection.

Hardware Installation

Connect the DC Power Supply to a line power outlet (100-240 volt, 50/60 hz) using the supplied Line Cord. This power supply *must* be rated for a maximum output of 9 volts DC, and no other voltage should be used, lest the activity monitors be damaged. Then plug the power supply output connector (5.5mm round with 2.5mm center cavity) into one of the 2 mating PSIU jacks, and verify that the adjacent green led illuminates.

Set the PSIU adjacent to the computer which is to be used for data collection, and connect the USB cable between the USB jack on the PSIU and any available USB port on the computer.

Connect the activity monitors to the PSIU telephone jacks using the wiring and accessories provided. If the system includes more than a few monitors, the wiring network will necessarily take the form of a tree, with 5-way splitters serving as nodes to connect multiple monitors to a single PSIU jack. The configuration of this network is largely unimportant, as long as the total cable length is restricted, and each monitor is connected to it.

In the case of large-scale systems with multiple incubators, wiring should include a separate cable directly from the PSIU to the interior of each incubator, and then a daisy-chain configuration of 5-way splitters inside, with a single splitter attached to each incubator shelf. Then short cables may be run from these splitters to the individual monitors.

System Checkout

Launch the DAMSystem3 application, and click on the *Preferences* tab. Select the Serial Port to match the USB serial port to which the PSIU is connected. In the case of the Macintosh, the synthesized port will be labeled TriKinetics PSIU, and in the PC will usually be the highest-numbered COM port in the list.

Choose the desired Reading Interval as well as the Monitor Range to match the set of physical monitors which will be used. These settings are adjusted by clicking the mouse pointer on the upper half to increment, and the lower half to decrement, and some settings will move as long as the mouse is held down.

Click the *Monitors* tab, and then the *Live* text immediately above, and verify that the selected range of monitor status boxes is scanned in sequence. All should be green for those monitors which are connected, and red otherwise.

To verify the performance of any single monitor, select its number below the *All* text, with *Live* still active, and see that real-time data is displayed. If a locomotor monitor, for example, pass a pencil point through a channel slot, and verify that the corresponding channel count increments. If an eclosion monitor, drop a fly down through the funnel, and again verify that it counts up (channel 1).

DAMSystem3 Data Collection Software

At launch, the program presents a single window, which is locked in place on the screen. No menus, popups, or other windows are used, and the program will run until Quit. Adjustments to settings are made by simply clicking on them, in the upper half to increment, and the lower half to decrement.

Settings are spread across 3 tab panels, each of which may be seen in turn by clicking its tab text in the upper left part of the window: *Preferences*, *Lights*, *Monitors*. Data collection will occur automatically no matter which tab panel is visible.

Reading Box

The Reading box (upper center of window) indicates the date and time at which the most recent data collection from the monitors was made. The index simply counts up from 1 with each reading, and along with the date and time, is stored in each monitor file with its monitor data.

Above the reading box is the countdown timer, which indicates when the next reading will occur. Readings take place at the interval specified in the *Preferences* tab.

Lights Box

The Lights box (upper right of window) shows the status of each light channel as reported by the Light Controller (if connected.) The colors of the boxes indicate the same status conditions as those of an activity monitor, with the exception that instead of green for valid data, the light boxes indicate orange for On, and blue for Off. Boxes which are visible have been activated in the *Lights* tab by selecting at least one pulse in the appropriate column of the selection matrix.

Quit

If the DAMSystem program is terminated, no periodic data collection from the activity monitors will occur. The monitors themselves will continue to count events as long as they have operating power, but these events will remain uncollected until the program is relaunched in the host computer.

Monitors tab

This tab panel shows the status of all monitors connected to the system. Select *File* and *All* to view the most recent reading status, with green boxes indicating monitors reporting data, red boxes indicating monitors not present, and black boxes indicating lack of communication with the PSIU itself.

Select *Live* and *All* to view the status of each monitor in turn as it is interrogated by the system. This mode is useful when monitors are first connected, for it allows a quick verification that all connections are proper, and that all monitors which should be reporting data, can do so.

To verify a single monitor, select the *Live* text, and use the mouse to increment/decrement *#NNN* to the monitor's number (1-120.) If the monitor is connected, it will be repeatedly interrogated for its current or live count totals, and all 32 will be displayed. In addition, the DAM2 monitor will display the status of its on/off ambient light sensor.

Similarly, the *File* and *#NNN* selections will display data for a single monitor from the most recently stored reading.

Preferences tab

All Preferences are saved automatically in the DAMSystem3Settings file, and are reloaded at startup after a shutdown. Default values are used if the file is not present.

To change a setting, left-click the mouse pointer on the upper half to increment, and the lower half to decrement. Some settings will change as long as the mouse is held down.

Reading Interval

The Reading Interval specifies the time between successive readings by the computer of monitor data. The readings will occur on submultiples of the hour, according to the computer time-of-day clock. Thus, a 10-minute setting will cause readings to be taken from all monitors at 0, 10, 20, 30, 40, and 50 minutes past each hour, generating 6 x 24 = 144 readings per day.

Monitor Range

These 2 numbers (1-120) specify the range of monitors which is assumed to be connected to the system, and which is interrogated for data at each reading. If a system includes a single monitor (#1) then the monitor range should be set for 1 to 1. Likewise, if monitors 10-19 are active, the range should be set accordingly. Monitors within the selected range which are not present will simply be recorded in the data folder with a reading status code of 51 and data values of 0.

Eclosion Monitor

These parameters control the periodic tapping of the solenoids on any and all Eclosion Monitors which are present on the network. *Tap Now* will cause the selected monitor to immediately tap.

Light Controller Sigma

This parameter (1 to 100%) controls the range of variation which is applied to the repeat period when the randomizer function is enabled (see *Lights* tab.)

Rotarod

The DPR6 Rotarod spins at an RPM which is controlled by this setting. Use the mouse pointer to select the desired RPM (+ or -) and then click *Set* to transmit the command to the device.

Serial Port

The Serial Port defines the input/output connection between the computer and the activity monitors. Legacy systems using the (Blue Box) Power Supply will be connected by an RS-232 serial cable to either a physical computer port or a USB/Serial adapter (Keyspan.)

Systems using the PSIU will connect to the computer by USB cable, and the Serial Port will be synthesized by the USB driver software. In the case of the Macintosh, the synthesized port will be labeled TriKinetics PSIU, and in the PC case will usually be the highest-numbered COM port listed.

To select or change the active port, simply click an entry in the Serial Port list. If the selected port activates, the selection will turn dark, but if the port is already in use or otherwise unavailable, it will remain light in color and an error message will display. To refresh the list of available ports, click the *Serial Port* list header.

Note that a serial port search will take place automatically if no port is available when a reading occurs, as when a USB cable is inadvertently unplugged. The system will try to reconnect with the lost port to restore communication with the monitors.

Data File Location

This column shows the absolute file path to the DAMSystem3Data folder on the hard drive where collected data is written to the Monitor files. As multiple copies of the DAMSystem3 program may be operating concurrently from different folders, this path information identifies the specific location of the data for this particular copy of the application.

Lights tab

The light timing system allows the host computer to independently control the On/Off timing of up to 6 external lights, often installed in incubators. The DAMSystem software calculates when the lights are to be turned on and off, and then activates solid-state relays within the Light Controller to perform the actual control. These relays selectively apply AC power to receptacles on the unit, to which the incubator lights are connected.

Light Channel Matrix

The software generates 8 independent pulses, each of which may be assigned to one or more of the physical light channels according to the matrix of check boxes. A light channel with a single assigned pulse will be On when the pulse is On, and Off when the pulse is Off.

When multiple pulses are assigned to a single light channel, the logic to combine them will be determined by the +/x symbol displayed below the pulse column. '+' (*or* logic) will cause the light channel to be on when *any* of its assigned pulses is on, and 'x' (*and* logic) will turn on the output only when *all* of the assigned pulses are on.

When a light channel is configured to be On, its corresponding outlet on the Light Controller will be energized with AC power.

Pulse Algorithm

Each pulse is individually controlled by 3 parameters: On Time, Duration, and Repeat Period. A pulse will be turned On when the Day of its On Time parameter is today (0), and the H:M:S of its On Time equals the H:M:S of the computer clock.

The pulse will then stay On for the H:M:S of its Duration parameter, after which it will go Off. As it does so, the Repeat Period parameter will be added to the On Time to form the new On Time for the next pulse. This On/Off cycle will continue at the Repeat Period for as long as the program is operating.

Several special cases are of interest. If the Duration is 0, the pulse will never turn On. If the Duration equals the Repeat Period, the pulse will never turn Off. If the Repeat Period is 0, only a single pulse will be output, and it will not be repeated.

Changing the Settings

To change a time setting, place the mouse pointer over the number to be modified, and hold down the (left) button. If the tip of the pointer is above the centerline, the number will increment, and if below, it will decrement. Note that some settings are restricted to multiples of the Reading Interval.

On Time

The On Time for each light pulse indicates the time of day at which the pulse either was, or will be, turned On. The digit in front of the hour indicates the day of turn-on, with '0' for today, '-1' for yesterday, and '+1' for tomorrow. As light pulses are turned on only at the Reading Interval, the On Time is restricted to multiples of this interval.

Duration

The Duration sets the length of time for which the pulse is to remain On after turn-on. The value may range from 00:00:00 (never On) to that of the Repeat Period (always On). If the Duration is set above the Repeat Period, it will be set to the Repeat Period when the settings are saved. The timing resolution is 1 second.

Repeat Period

The Repeat Period sets the rate of pulse cycling, and with the Duration, controls the duty cycle or 'On fraction' of the pulse. The pulse will be On for (Duration/Repeat Period) fraction of the time. If the Repeat Period is set to 0, only a single pulse will be output, and it will not be repeated. The maximum setting is 99 hours, or just over 4 days at 24 hours each.

Random Repeat Period

The Repeat Period may be randomized to vary the stimulation from pulse to pulse. To activate this function for any pulse, click in the space to the right of the Repeat Period, toggling through 3 options: Rn(randomize normal), Ru(randomize uniform), and blank(no randomness). Operation is as follows:

For any pulse with its flag set to Rn, the Repeat Period becomes a normally-distributed random variable, with a mean equal to the nominal (displayed) value, and a standard deviation equal to the Sigma fraction of the nominal Off Time (Repeat Period - Duration). All Repeat Period values will be within the range of Repeat Period +/- Off Time. The Sigma parameter (*Preferences* tab) will adjust the width of the distribution, with 1% providing little variation in the Repeat Period, and 100% providing wide variation over the allowed range.

For any pulse with its flag set to Ru, the Repeat Period becomes a uniformly-distributed random variable, with a mean equal to the nominal (displayed) value, and a maximum deviation equal to Sigma times the nominal Off Time. Thus, in this case Sigma does not represent a true standard deviation, but instead defines the absolute limits of the uniform variation about the nominal value as a fraction of the nominal Off Time.

In all cases, an immediate repeat may be generated, but only at the conclusion of a pulse, and thus no partial pulse repeats will occur. Note that as long as the pulse duration is at least as great as the reading interval, the MonitorLC or DayLight file will contain a record of the pulse times. Note also that the pulses

may only be initiated at the beginning of a bin, so the Repeat Period must be substantially greater than the Reading Interval for the randomizer to be effective.

Examples

1. 24hr light/dark cycle: On at 8:00 AM, Off at 8:00 PM

   OnTime = 0 08:00:00 Duration = 12:00:00 Repeat Period = 24:00:00

2. Single Pulse: tomorrow at noon for 30 minutes

   OnTime = +1 12:00:00 Duration = 00:30:00 Repeat Period = 00:00:00

In each case, the check boxes in the row of the pulse *must* be checked at the column of the channel(s) it is to control if it is to have any effect on the hardware.

Hints

A single pulse (of the 8) may be used to control multiple light channels if all are to cycle On/Off simultaneously. Simply check the boxes for these channels in the row of the pulse, and all will be controlled.

A finite string of pulses may be generated by combining several of the 8 pulses, each of which is set to produce a single pulse. Thus Pulse 1 could generate a single pulse today (0 H:M:S), Pulse 2 could generate a single pulse tomorrow (+1 H:M:S), and so on, up to 8 pulses.

A single long pulse may enable or gate a series of short pulses by using the 'x' (*and*) logic symbol. Thus a 1-hour sequence of short 1-minute pulses would be generated by "x" combining on a single channel the 1-hour pulse with a repeating 1-minute pulse. The channel output will only be On when both pulses are On. (If, however, the '+' (*or*) symbol is used instead, the channel will be On whenever *either* pulse is On, negating any effect of the 1-minute pulse.)

Data file management

Monitor data is saved in the individual Monitor text files in the DAMSystem3Data folder. This folder resides in the same directory with the DAMSystem3 application, as does the DAMSystem3Settings file and the DAMSystem3Log file. All of these files are automatically generated by the program when necessary.

At the conclusion of an experiment, the relevant Monitor files (perhaps only a few of the total) should be moved (dragged or cut/pasted) out of the DAMSystem3Data folder and into another folder on the computer. This will effectively terminate the data collection, for at the next reading the program will create new Monitor files for these monitors, and begin writing new data into them. Thus the files just moved will contain the activity records for the experiment just ended, and a new set of files will begin for the next one.

The moved monitor files, now disconnected from the data collection process by being out of the DAMSystem3Data folder, may be transferred to another computer for archival storage, FileScan, and analysis or plotting. (See Reference for the format of these 42-column monitor files.)

Multiple systems on one computer

The DAMSystem3 application allows multiple copies to run concurrently on one computer, each connected to a separate PSIU and monitor network. This facilitates large systems where monitor numbers may overlap, or wiring concerns mandate simplification.

To use this option, duplicate the DAMSystem3 application and place each copy in a separate folder. This will keep separate the settings and log files and monitor data files for each system.

Then launch each in turn, and note how the windows are staggered on the screen and labeled in the upper right corner with a sequence number (1-5). The *Preferences* tab for each window shows the path to the particular folder which contains the application copy and monitor data for the system. In all respects the systems are independent, each with its own settings and files, and there should be no deleterious interaction between them. Serial port assignments, however, must be monitored carefully, especially at program launch and restart to insure that the correct port is assigned to the correct system.

DAMFileScan Software

This program scans DAMSystem3 Monitor data files, and produces validated output files at any bin length. Use it as follows:

1. Select Input Data Folder to choose the location of the DAMSystem3 data files. File names must be of the form MonitorNNN.txt, where NNN = 1 to 120 or LC for Light Control. Files must consist only of 42 tab-delimited columns.

2. Choose the monitor range to be scanned.

3. Click Scan to initiate read and review of the input files. Results include the earliest and latest readings for each file, number of readings with errors, and total number of readings. Uncheck the Verify Data box to speed up scanning if the input files are known to be good.

4. Choose the first and last bins to be saved, and the output bin length.

5. Choose the File Type. Monitor files are of the same format as the input files, and Channel Files are of the legacy DAMSystem2 format, 32 per monitor.

6. Multiple input readings within the time frame of a single output bin are combined either by sum or average. The number of these 'extra' readings is reported for each bin in column 5 of the output monitor file.

7. RunName specifies the name of the output data folder, which will be created alongside the input folder. The individual output files will be named with the RunName prefix.

8. Click Save to produce the output files. Results for each monitor are reported as follows:

R = Input readings included in output

E = Input readings with errors (output as 0)

S = (Skipped) output bins with no input data (output as 0)

X = Extra readings (combined into output)

Preview reports as Save, but produces no output files.

9. Save Log adds this log to file DAMFileScanLog.txt.

Input data is contained in 'readings', which may or may not be periodic, and sequences of which may contain gaps. Output data is produced in 'bins', which are guaranteed to be periodic and sequentially complete.

Hints

1. Skipped and Extra readings are not associated with specific monitors, or even the Power Supply Unit, but instead with the time sequence of the readings as they are collected by the DAMSystem3 program. If the output file Bin Length in DAMFileScan is set differently from the input file Reading Interval used by DAMSystem3 to collect the data, then Skipped or Extra readings will be generated in the output files, even if such errant readings do not exist in the collected data. Such skips or extras are strictly artifacts of the modified bin length, and are not malfunctions of the data collection system.

2. If an unexpected number of skipped or extra readings is reported, reduce the number of readings and repeat Preview to determine when the readings were added or dropped. Extra readings will be produced if the Reading Interval is shortened in the middle of an experiment, and readings will be skipped if the data collection process is interrupted by a power failure or program termination.

3. Separate groups of monitors may be saved into the same RunName folder, even though a warning message is displayed when the second group is attempted. Simply click the Save button again, and the save will occur into the existing folder. Note that any existing files in the folder with the same names will be overwritten, so be careful.

Hardware

A complete DAMSystem installation must include a host computer, a Power Supply Interface Unit, and one or more activity monitors of any or all of the following types:

DAM2/DAM5 Activity Monitor (32 channels for 5 or 7mm tube)

DEM Eclosion Monitor with Tapper (1 channel for 100-mm funnel)

DPM Population Monitor (3 channels for single 25-mm vial)

DEnM Environment Monitor (Temperature, Humidity, Ambient Light)

LC3 Light Controller (1 to 6 channels)

The computer connects to the Power Supply Interface Unit with a USB cable, and the PSIU connects to the activity monitors with a network of 4-conductor flat telephone cables.

Monitor Addresses

Each monitor on a DAMSystem network must be identified by a unique numeric address so that it may be individually accessed by the host computer. As the maximum number of monitors on a single system is limited to 120, the range of valid addresses is 1 to 120. The address of each monitor is set at the time of manufacture, and can only be changed if the unit is returned to the factory.

Host Computer

A host computer is required to collect and store data from the activity monitors. While the monitors themselves actually detect and count the activity events, a host computer is necessary to periodically acquire this data from the monitors, and hold it for the length of an experiment.

This computer may be either an OSX Macintosh or Windows PC, and should be physically located adjacent to the activity monitors. As it will need to run reliably and untended for extended periods of time, its software load should be minimized to avoid the potential for a software crash which might interrupt data collection. If no other applications are active in the computer during an experiment, and no network access is allowed, the likelihood of such a software crash will be diminished.

Macintosh

Any model of Apple desktop or laptop Macintosh computer may be used to collect the monitor data, as long as it has available a free USB port to connect to the PSIU. If no such port is available, a USB expansion hub will be required (available in any computer store.) Software versions of the DAMSystem program, and the requisite USB drivers, are available under OSX for both the PowerPC and intel Macintosh families.

Windows PC

Any PC model which runs the Windows98 or later operating system, including WindowsXP and Vista, may be used with this program, as long as a USB port is available to connect to the PSIU. As in the Macintosh case, a software driver will need to be installed into the computer to operate the USB link to the monitors.

Power Backup

The computer and activity monitor Power Supply should be protected against power failure to insure continuous data collection over an extended period of time. A battery-backup UPS can provide protection against short-term (30 minute) power outages, and if a backup generator is available in the lab facility to provide standby power thereafter, no power interruption to the computer should ever occur.

To minimize data loss in the event that the computer actually does lose power and stop, the computer should be set to automatically restart when the power returns, and then automatically relaunch the DAMSystem program. This will allow data collection to resume on its own, minimizing the number of skipped readings.

PSIU Power Supply Interface Unit

The *Power Supply Interface Unit* and its companion DC Power Supply(s) provide 9 volt DC operating power to the activity monitors. One unit is required for each complete system, which may include up to 120 individual monitors of various types.

DC Power Supply

The PSIU and all activity monitors connected to it are powered from an external 9VDC power supply, which connects to the PSIU through one of the two power input jacks. These jacks accept a round 5.5mm OD by 2.5mm ID power plug, with the center pin positive polarity. Only 9V DC supplies must be used.

To provide redundancy, the PSIU provides 2 input power jacks, each of which may be connected to a 9V power supply. In this case, the 2 supplies will share the power load to the monitors, and either will continue to provide power in the event of failure of the other. Because of this failure possibility, each supply must be rated to deliver the full current load of the system by itself.

USB Connection

The PSIU connects to the host PC or Macintosh computer with an 'A-B male' USB cable. Any free USB port on the computer may be used, and if none are available, a USB hub may be used to add ports. Note that the DC Power Supply must be connected to the PSIU to enable the USB computer link.

Software Drivers

All USB devices require *drivers* to inform the host system of their characteristics. Drivers for the PSIU may be downloaded from the TriKinetics web site, and must be installed for the PSIU to be recognized.

Checkout

To verify that the PSIU is operating properly, perform the following steps:

1. Unplug the USB cable and all monitor data cables from the unit.

2. Connect a 9 volt DC power supply to one of the PSIU power input jacks, and connect the supply to the AC mains power. Confirm that a green light on the PSIU is On, and the yellow light is Off.

3. Connect the USB cable from the PSIU jack to a computer USB port.

4. Verify that the USB driver is loaded properly and that the USB port is activated. To do this on a Macintosh, launch the System Profiler (About This Mac, More Info...), and verify that the Hardware:USB Device Tree contains TriKinetics PSIU.

On a Windows PC, launch the System Control Panel (Start, Settings, Control Panel, System), and verify that the Hardware Device Manager:Ports (COM and LPT) list contains TriKinetics PSIU (COMn) or CP210x USB to UART Bridge Controller (COMn).

5. Launch the DAMSystem program, and select the *Preferences* tab. Verify that the Serial Port points to the PSIU (TriKinetics PSIU on Macintosh, COMn on Windows.)

6. Return to the *Monitor* tab, click on *Live*, and verify that the monitor status boxes are Red in color (Status 51) and not Black (status 50).

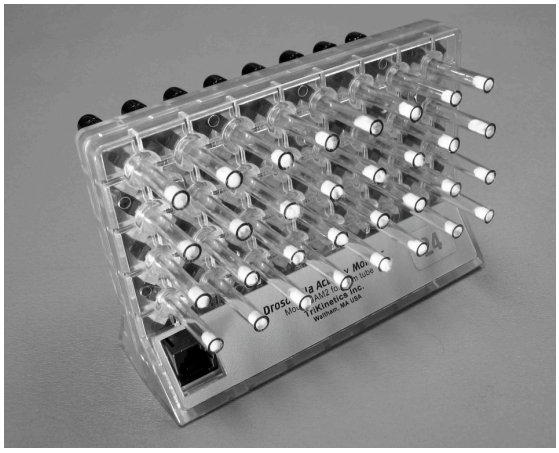
7. Verify that the yellow light on the PSIU flashes as each status box is updated.

8. Plug the monitor network cables into the PSIU telephone jacks, and verify that both the green light stays On, and the yellow light continues to flash.

If these steps are successfully performed, the PSIU is operating properly, and the computer should be able to acquire data from installed monitors.

DAM2 Drosophila Activity Monitor

The DAM2 monitor measures the simultaneous individual activity of 32 flies, each in a separate tube. As a fly walks back and forth from end to end, its passage is detected and counted by an infra-red beam which bisects the tube, and the accumulated count totals are reported to the host computer at the conclusion of each reading period.



Monitors are built for either 5 or 7mm tube diameter, and should be selected according to the size of the fly. It is possible to use even the 5mm size with multiple flies per tube if this is of interest for added throughput or the study of social effects.

Tubes

We supply tubes in Corning Pyrex glass (5 or 7mm diameter by 65mm length, and polycarbonate plastic (5mm diameter by 65mm length.) Both materials are transparent, and may be washed and autoclaved for cleanliness and sterility.

Alternate tube lengths and diameters are available on request.

Fly Food

A food mixture must be placed into one end of each tube to sustain the fly over the course of a multi-day experiment. Many recipes are reported in the literature, but a simple one which works is as follows:

100 ml water

5g sucrose crystals

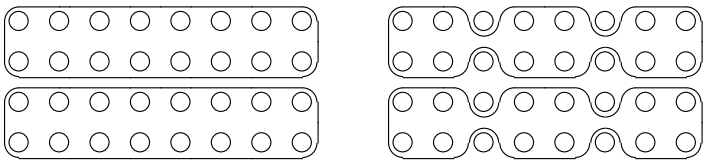
2g agar powder

Combine the ingredients in a glass beaker, and bring carefully to a boil using a hot plate or microwave oven. When the solids are completely dissolved, pour the solution slowly down the side of another glass beaker containing the glass tubes standing on end, to a level of about 15mm deep. Allow the mixture to cool and solidify. Carefully remove the tubes from the agar matrix, sealing the tops with a finger to retain the food, and wipe them clean. Then seal the food end of each tube with either a quick dip in melted paraffin wax or a plastic cap to prevent desiccation. The flies may now be loaded, one into the open end of each tube, and the tubes then plugged with cotton.

Monitor Setup

Tubes containing flies must be the proper diameter, and may have a wax coating or plastic cap on one end to seal the fly food. Insert the tubes through the 32 holes in the monitor, and leave them centered so that the detection beam will bisect the tube.

If captivation of the tubes is necessary to prevent sliding, use #14 rubber bands, stretched first over the 4 corner tubes of 2 adjacent rows, and pressed up against the monitor surface. Then remove the tubes from columns 3 and 6, and reinsert them from above and below the bands as shown to place them into frictional contact.



With the tubes installed, the monitor may be plugged into the DAMSystem network.

Ambient Light Sensor

Each unit contains an ambient light sensor, which may be seen adjacent to the hole for tube #1. This sensor is set to discriminate light from dark at a nominal threshold of 10 lux, and will report its output with the count data at each collection bin. With the *Monitor* tab set to *Live* and *#nnn*, the sensor output will be displayed in real time, and may be used for diagnostic purposes. When *File* data is retrieved from the monitor at the end of each bin, the light sensor will report dark(0) only if dark for the entire preceding bin. If the sensor measures light above its threshold at any point during the bin, it will report light(1) for the bin, serving to detect door openings or other lights-on transients.

The sensor output is reported in column 10 of the MonitorNNN file.

Incandescent Light

The light detectors used in the counting beams are sensitive to ambient light in the infrared band, as would be emitted from a hot incandescent bulb. Such external light will normally not prevent the counting circuits from detecting fly movement, but may cause false counts if the level of such light changes rapidly (as when the light turns on or off, or is shadowed.) Fluorescent lights, emitting principally in the visible band, will not cause such transient counts.

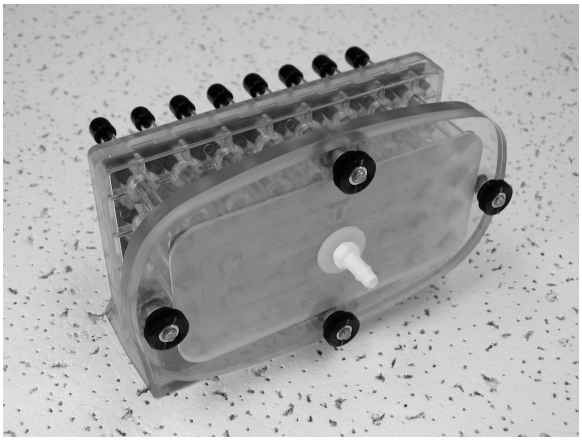
Data Collection

To verify that the monitor is operating properly, return to the *Monitor* tab and show *Live* data for the single monitor (*#nnn*) in question. The status box should be green (status 1), and the 32 channels of real-time count activity should be displayed. If a thin object such as a pencil point is moved through one of the tube cavities, the count total for that channel should increment.

The monitor will accumulate activity counts for as long as it has operating power, and will uplink its accumulated counts (and then reset to 0) whenever commanded to do so by the host computer. Counts will be accumulated as the flies are active in both total darkness and bright ambient light.

MAN2 Gas Distribution Manifold

This accessory for the DAM2 activity monitor provides for controlled gas flow through the tubes, with a common inlet port and individual Oring-sealed exit ports to each of the 32 5mm tubes. Small exit holes in the tube sides near the opposite ends allow gases to escape, but not the flies.



Insert tubes into the manifold holes by wetting the tube ends prior to insertion. Insure that the tube is perpendicular to the manifold face, and spin gently if resistance is encountered. Do not force the tubes into the holes, lest the O-ring seals be damaged.

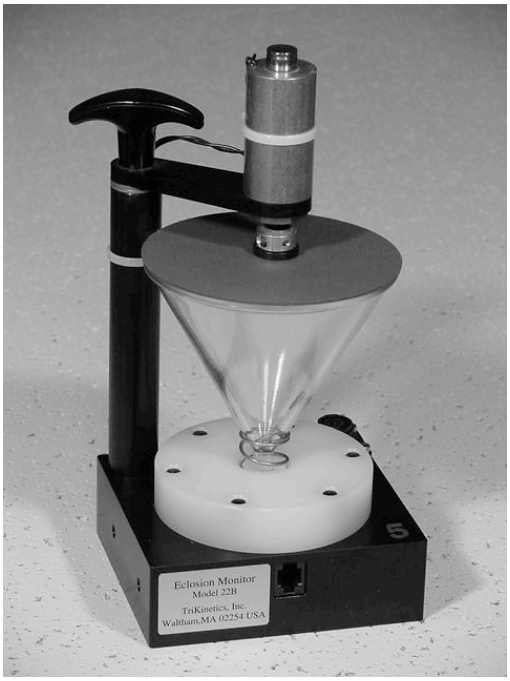
A large #84 rubber band serves to seal the manifold cavity against leakage between the halves. Tape may also be used.

Disassemble the manifold halves be removing the rubber band seal and the 4 thumb-nuts. Clean as necessary, and insure that any and all debris is removed from the mating surfaces prior to reassembly to prevent leaks. Align the ‘T’ indents for repeatability.

The inlet tube fitting accepts 3/16” ID flexible tubing.

DEM Eclosion Monitor

The *Drosophila Eclosion Monitor* uses a glass funnel to collect emerging flies from pupae cases affixed to the underside of a plastic disk. Unable yet to fly, the insects fall down through the funnel neck, where an infrared beam array detects and counts their passage.



As flies are 'sticky' on eclosion, some tend not to fall, but instead remain adhered to the disk or funnel walls until able to fly. To prevent this, a solenoid periodically taps the spring-mounted disk/funnel stack to dislodge those flies which have not yet fallen.

Mechanical Setup

The unit should be placed on an incubator shelf, so that the funnel stem may protrude down through and below the base. The funnel is Kimble #28950-100, and should *not* be replaced with any other type if the tapping mechanism is to be used. If the tapping mechanism is not needed, then any funnel whose stem is 9mm or less in diameter should work.

If the funnel is not installed, loosen the large knob which holds the solenoid bracket to the post, lift up the arm over the restraining pin, and rotate the arm to the side. Gently slide the funnel stem down through the coil spring and into the hole in the top of the nylon block - lower it all the way down until the funnel bell rests on the top of the spring. Note that in this position, the end of the stem will protrude through the bottom of the unit by about 1 inch.

Place the thin plastic disk over the funnel mouth, with the stepped edge to the inside of the funnel. Push down on the center of the disk, and verify that the funnel slides smoothly up and down in the nylon block, compressing the spring.

Hold the funnel in its 'down' position, and rotate the solenoid bracket over the center of the funnel and disk. Tighten the T-handle to secure it in place, insuring that the restraining pin goes through the alignment holes in the washers.

Release the funnel, and verify that the spring pushes the funnel/disk stack up and into the solenoid plunger, which also moves up. Press down and release the top of the solenoid plunger, and verify that the stack moves smoothly down and up. The funnel must *not* 'bottom out' on the nylon block when the plunger is all the way down, else it may break.

Solenoid Timing

Solenoid timing is controlled from the *Preferences* tab - the number of taps and their frequency. The *Tap Now* text will cause an immediate tap sequence for the selected monitor.

Note that the monitors tap in sequence, so that only a single monitor taps at a time. Monitor 1 will tap immediately after the time-of-day clock initiates the sequence, and then each monitor will tap in turn. To inhibit all tapping, set the Tap Count to 0, and to inhibit the tapping from a single monitor, unplug its solenoid cable.

Data Collection

The unit counts all objects greater than 0.5mm in extent which fall down through the funnel neck, and is quite adept at discriminating multiple objects in rapid succession. The unit reports 32 channels of counting activity to the host computer, but all will be 0 save channel 1, which contains the count total.

Troubleshooting

To verify that the unit counts properly, remove the plastic disk from the funnel top, and set the DAMSystem *Monitor* tab to show *Live* data for the monitor in question. Verify that the unit status is 1, and that the

32 channel numbers are displayed and updated. If 1 is not the status, check that the unit is plugged in to the DAMSystem network, and consult Troubleshooting in the Reference section. Drop some small objects down through the funnel, and verify that the channel 1 count increments with each one.

The tapping intensity may be adjusted by changing the number of flat washers between the top of the round post and the solenoid bracket. More washers will raise the solenoid up, providing a firmer down tap and softer return. Fewer washers will lower the solenoid, with contrasting results. The units are initially adjusted to provide firm contact on both up and down strokes, and if set right, the flies will be nudged down through the funnel neck before they have a chance to take wing. Silicone coating of the funnel interior will also help with this.

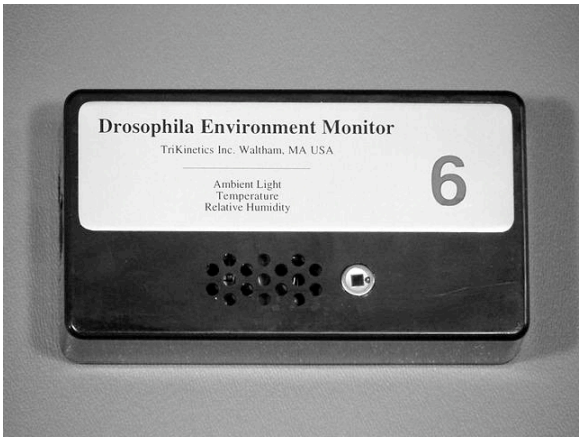
The counting electronics is quite sensitive, and will count the taps of the funnel if specs of dirt on the funnel neck pass by the detectors as a fly would. Keep the funnel neck clean to prevent such spurious counts.

Mounting holes are provided in the sides and bottom of the unit to hold it in place if necessary. The holes in the bottom are especially useful for clamping the unit to an incubator shelf so that it does not 'walk' during taps.

The tapping solenoid draws a substantial current from the Power Supply, and if the total cabling distance between the 2 becomes excessive, the resulting voltage drop will reset the unit. To prevent this, a maximum separation of 15' (5m) should be used.

DEnM Environment Monitor

The *Drosophila Environment Monitor* continuously measures the temperature and relative humidity of its surrounding air, and the illumination of its top surface. At the end of each reading interval, the monitor reports not only the current state of the 3 sensed parameters, but also their respective minimum, average, and maximum values during the interval. In addition, the average illumination level for a succession of 2-minute bins is reported in channels 17-32, as shown below.



Channel 17 reports the average light level measured during the first 2 minutes of the interval, channel 18 reports the average level for minutes 3 and 4, and so on. These 2-minute averages allow for detailed monitoring of the light level in an incubator, where the door may be briefly opened, or the interior lights cycled on or off during the bin period. By comparing these 2-minute averages to the overall bin average (channel 4), a good profile of the lighting activity may be obtained.

Data Format (32 channels)

1	0 (always)	
2	Lnow	current illumination level (lux)
3	Lmin	minimum over the current bin
4	Lavg	average
5	Lmax	maximum
6	0	
7	Tnow	current temperature (degC x 10)
8	Tmin	minimum over the current bin
9	Tavg	average
10	Tmax	maximum
11	0	
12	Hnow	current relative humidity (percent)
13	Hmin	minimum over the current bin
14	Havg	average
15	Hmax	maximum
16	0	
17	minutes 1:2, average illumination level	
18	minutes 3:4	
19	minutes 5:6	
20	minutes 7:8	
21	minutes 9:10	
22	minutes 11:12	
23	minutes 13:14	
24	minutes 15:16	
25	minutes 17:18	
26	minutes 19:20	
27	minutes 21:22	
28	minutes 23:24	
29	minutes 25:26	
30	minutes 27:28	
31	minutes 29:30	
32	minutes 31:32	

Light Measurement

Incident light intensity is measured by the round silicon photodiode sensor on the top surface. The green filter absorbs wavelengths outside of the visible band, providing a sensitivity curve which approximates the photopic response of the human eye. The sensor is calibrated to a fluorescent light, as this is the dominant light type for incubators, and will be accurate over the range of 1:2500 lux to 5% for any light of this type. Incandescent lights will read higher because of their substantial infrared energy output and the imperfect attenuation of these wavelengths by the sensor filter.

The light sensor will not be damaged by illumination levels which exceed 2500 lux, but the numeric output will eventually saturate, going no higher. The wavelength of maximum sensitivity is 550 nm, falling to 10% of maximum at 350 and 820 nm. Linearity is 1% or better.

Note that the specified sensitivity is measured along the axis of the sensor, directly perpendicular to the plane of the front surface. Off-axis sensitivity will be lower, decreasing to 50% at 55 degrees away from the axis.

Temperature Measurement

Ambient temperature is measured by a precision thermistor, which sits just under the perforation holes in the top of the unit. It is calibrated to 0.1 degrees Centigrade, and should be accurate to this level over the range of 0 to 70 degrees. The time constant of the sensor is largely determined by the thermal mass of the unit enclosure, though any airflow through or over the unit will significantly speed up the response. A large temperature change in still air will take over 1 hour to stabilize to 0.1 degC, but smaller changes to less precision will occur much more quickly.

Negative temperature values are not output, the lower limit being set at 0.0 degC, and no damage will occur if the unit is exposed to lower temperatures than this. Elevated temperatures above 70 degrees C should be avoided.

Humidity Measurement

Relative Humidity is measured by an electronic sensor which is mounted under the perforation holes of the case top. Its range of operation is 0 to 100%, with a calibrated accuracy of +/- 2%. Its speed of response is also determined by the diffusion rate into the unit interior, measured in minutes. The unit will not be damaged by condensation, but its output will saturate at 100% until the surface moisture evaporates. Be aware that moving a unit to or from cold environments may precipitate condensation, and the resulting saturated readings.

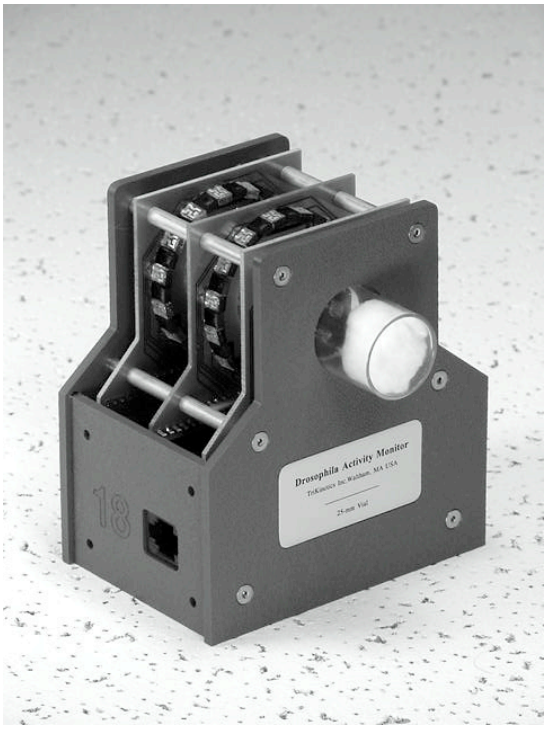
Temperature-controlled incubators often use fans to circulate heated or cooled air into the interior chamber. The temperature and relative humidity of such circulating air may be substantially different from the air of the bulk interior, and will oscillate over time as the incubator controller adds or removes heat from this air to maintain the temperature and/or humidity setpoints. If the Environment Monitor is placed in this airflow, it will record these oscillations of the control air rather than the temperature and humidity of the bulk interior air. To avoid these effects, place the monitoring unit out of the circulating air path, and consider using the ‘average’ values rather than the ‘now’ values if there is substantial variation in the latter.

Packaging

The unit is packaged in a rectangular plastic enclosure of nominal size: 110 x 60 x 30 mm, and connects to the monitoring system using the standard 4-wire telephone jack. The case is perforated on the top and bottom to provide convection airflow over the temperature and humidity sensors, which are internal to the box. For this reason, special care should be taken to insure that no liquids are spilled onto the box.

DPM Population Monitor

This monitor is designed to measure the activity of drosophila in 25-mm diameter plastic or glass vials of 95-mm nominal length. With a food mixture in the bottom of the vial, and an air-permeable plug or cap on the top, the vial may be inserted into the unit until the bottom rests on the stop washer.



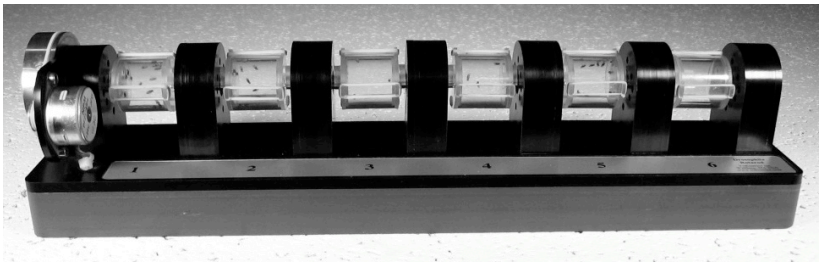
The 3 rings of infrared emitter/detectors each detect the passage of individual flies through their respective ring, and report the cumulative 'counts' to the host computer as monitor channels 1, 2, and 3 of 32. Channel 1 is derived from the bottom ring, that closest to the stop washer at the vial bottom, channel 2 is in the middle, and channel 3 is at the top, closest to the vial opening. The balance of the 32 channels will always record 0.

Flies are detected as they move through the infrared beam cross section, and thus 2 flies which move simultaneously through the beam ring may be detected as one. Such dropouts will begin to affect counting accuracy as the number of flies in the vial is increased. Also, the detection electronics is tuned for walking flies, and may miss those which quickly jump or fly through the beam ring.

Mechanical

The monitor may be placed in a horizontal or vertical position for operation. The stop washer may be adjusted in or out with a nut driver or socket wrench to position the vial axially relative to the detector rings. Such a stop provides a registration basis for repeated measurements at a consistent position along the vial axis.

DPR6 Rotarod



The Drosophila Rotarod uses 6 rotating glass tubes to challenge the geotactic facility of one or more flies. 5 infrared beams, placed at 60-degree increments around from the tube bottom, shine axially along the inner diameter of each tube wall, and detect the passage of flies on the wall. Flies which hold the wall for a complete turn will break all 5 beams, and register counts on each beam channel, whereas flies which fall off part way around will register counts on only some of the channels.

Tube Assembly

Tube sections consist of a 25mm diameter glass cylinder, and 2 end plates with integral mounting clips. Wash the cylinder and end plates thoroughly, being careful not to scratch them. Install the cylinder onto 1 end plate, load the flies, and install the other end plate, holding the assembly together with your hand. Rotate the end plates about the cylinder axis to align the U-shaped mounting clips in the same direction, and verify that the opposing circumferential tabs are also aligned. Stretch 3 #8 natural rubber bands along the outside of the cylinder between the tab pairs to hold the tube assembly together.

Tube Insertion and Removal

To install a tube assembly into the unit, align the open ends of the U-shaped clips over a pair of protruding trunnion hubs in one of the 6 tube positions, and press down to snap the clips into place. The tube should be securely held, aligned with the axis of rotation, and free to rotate with the other tubes and motor.

To remove a tube assembly, first stop the motor rotation, and then rotate the tube by hand until the open ends of the U-shaped clips face upward. Then, while holding the tube, push down on it to release the clips from the hubs, and remove it from the unit.

Spin Rate Control

The small motor spins the tube string through the large brass pulley using a single #14 natural rubber band. The band should be centered in the grooves of the 2 pulleys, and smoothly transmit the motor power from one to the other. The speed and direction of rotation are set in the *Preferences* tab of the DAMSystem program, and are reported back from the unit in channel 16. 'Positive' rotation is defined as up from the bottom and toward the label side or front of the unit.

Channel 32 reports the output of a shaft rotation sensor which is located in the final tube support, outboard of tube #6. This sensor increments its count once per revolution, and indicates the number of actual turns of the tube string, which may be slightly different from that commanded due to variation in the drive belt.

Data Format (32 channels)

1	Tube 1 Sensor A 60 deg
2	Tube 1 Sensor B 120 deg
3	Tube 1 Sensor C 180 deg, top
4	Tube 1 Sensor D 240 deg
5	Tube 1 Sensor E 300 deg
6	Tube 2 Sensor A
7	Tube 2 Sensor B
8	Tube 2 Sensor C top
9	Tube 2 Sensor D
10	Tube 2 Sensor E

11 Tube 3 Sensor A
12 Tube 3 Sensor B
13 Tube 3 Sensor C top
14 Tube 3 Sensor D
15 Tube 3 Sensor E

16 Command RPM, 100+ = minus direction

17 Tube 4 Sensor A
18 Tube 4 Sensor B
19 Tube 4 Sensor C top
20 Tube 4 Sensor D
21 Tube 4 Sensor E

22 Tube 5 Sensor A
23 Tube 5 Sensor B
24 Tube 5 Sensor C top
25 Tube 5 Sensor D
26 Tube 5 Sensor E

27 Tube 6 Sensor A
28 Tube 6 Sensor B
29 Tube 6 Sensor C top
30 Tube 6 Sensor D
31 Tube 6 Sensor E

32 Rotation sensor count, magnitude only

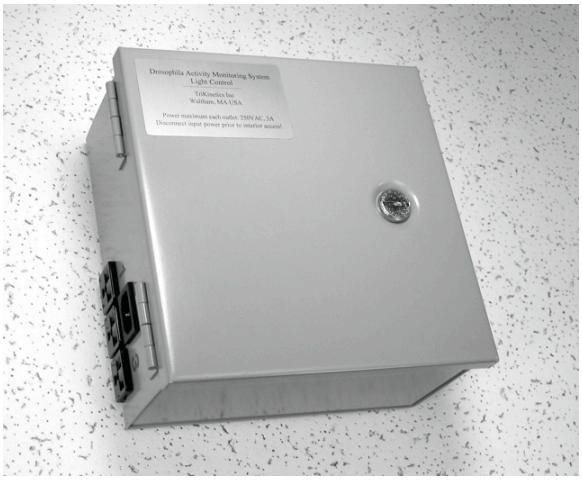
Troubleshooting

First verify that the rotarod unit is communicating properly with the host computer (status code 1.) Then rotate the brass flywheel by hand, and verify that all tubes spin properly on their respective hubs, and that the motor pulley spins via the rubber drive band. Then command motor rotation via the *Preferences* tab, and verify that rotation is smooth and constant. Select *Live* and *#nnn* (*Monitor* tab) , and verify that the channel 32 rotation sensor increments once per turn.

If the motor and tubes turn properly, then remove all tubes and carefully clean them with their end plates. Then install the empty and clean tube sections, and command a motor rotation. Verify that all 30 channel counts (5 per tube) read 0 after the next data collection, and remain at 0, indicating that the tube sections are clean and ready for flies.

Note that any dirt or foreign matter on the tube end plates or inner walls will be detected as a fly if it blocks an infrared beam with sufficient opacity,

LC3/LC6 Light Controller



The Light Controller allows the DAMSystem software to directly schedule incubator light timing on up to 6 independent light channels. By bypassing the simple internal timers that many incubators have, the Light Controller hardware and DAMSystem software combination makes available a wide array of pulse patterns for both entrainment and stimulus/response purposes.

Each light channel is switched on/off by a solid state relay within the LC3/LC6 enclosure. The relays are rated for up to 240VAC, 50/60 hz operation at 3 amperes, and each is fuse protected against overload.

An input AC line cord provides power to the relays, and output cords provide switched power from the relays to the lights to be switched. The connectors for AC input and output are the North American standards: IEC60320 C13 for input and NEMA 5-15 for output.

To use these controls for incubator lighting, the lights must be disconnected from the internal incubator timers, and connected instead to conventional line cords with plugs suitable for connecting to wall power. Make sure that the ballast transformers for the lights are included in the circuit with the line cords - test each cord by plugging it into a wall outlet. If the lights work properly in this case, the cord may be plugged into the LC3/LC6 for DAMSystem control.

NOTE: *electrical connections to the incubator lights must be made by trained electricians only.*

Installation

1. Launch the DAMSystem program and enable at least one of the light control channels (Checkbox matrix in the *Lights* tab.)
2. Connect the Light Controller to the DAMSystem network with a phone cable and verify that the light status boxes (upper right of DAMSystem window) turn orange (on) or blue (off) in *Live* mode.
3. Connect an AC cord to the input power receptacle and a standard table lamp plug to one of the output receptacles. Adjust the settings in the *Lights* tab to make the channel go on (at the next collection bin) and verify that the lamp does indeed come on.
4. Plug the incubator light cords into the output receptacles in place of the test lamp and adjust the *Lights* tab settings to control the lights as desired.

Notes

Light pulses are initiated only at bin boundaries, though they may terminate at any time according to the Duration setting. The light status boxes are updated as each bin begins, just prior to any command changes to the lights. Thus the status box and status record in the LC file reflect the state of the lights in the bin just ended (aligning itself with the data collected, which similarly reflects activity in the bin just ended.)

Fuses are provided in each of the relays to protect against overload. In the event of fuse replacement, the exact same size and rating *must* be used.

The light status boxes reflect the On/Off state of the lights as commanded by the software and reported back by the controller. If a fuse is blown or a cable unplugged, the status will clearly be incorrect, and only a direct measurement of the light level itself will tell the real story. (See DEnM Drosophila Environment Monitor or DAM2 Ambient Light Sensor.)

Reference

Status Codes

Each attempt by the host computer to read data from an activity monitor results in a numeric status code which indicates whether or not the read was successful. The value of this code is also indicated by the color of the monitor status box, as follows:

Code	Color	Status
1	Green	Good data read
24	Yellow	Monitor power-on reset
50	Black	No connection to Power Supply Unit
51	Red	No monitor response
52	Red	Communication fault: Sync
53	Red	Communication fault: Address
55	Red	Communication fault: Checksum

Any code other than 1 indicates that no data was received from the monitor. Codes other than those listed above indicate internal monitor or system faults, and should be reported to the manufacturer at support@trikinetics.com.

Output File Formats

All data output files are text files, and may be viewed or edited with any text editor. Text lines are terminated with CRLF on both Macintosh and Windows platforms for compatibility.

Monitor File

Monitor files are produced by DAMSystem3 directly, and are contained in folder DAMSystem3Data until moved elsewhere. They are named MonitorNNN.txt (NNN = 1-120) or MonitorLC.txt for the Light Controller, and contain 1 line for each reading in 42 tab-delimited columns.

Monitor files are also produced by the DAMFileScan application, as selected and validated versions of the raw MonitorNNN files. These processed files are contained in the MyRun folder, and are named MyRunMNNN.txt or MyRunLC.txt, where MyRun is the name selected in the DAMFileScan program.

The 42 tab-delimited columns of the monitor file format are as follows, with all being numeric except columns 2 and 3:

1	Index at reading (from 1 with each program restart)
2	Date of reading (9 Dec 06)
3	Time of reading (19:09:30)
4	Monitor status (1 = valid data received)
5	Extra readings included in this bin (DAMFileScan outputs only)
6	unused (0)
7	unused (0)
8	unused (0)
9	unused (0)
10	DAM2 Light Status (1 = On, 0 = Off)
11	Channel 1 - activity counts
12	Channel 2
...	...
42	Channel 32

Light Control outputs are reported as Channels 1-6 of the MonitorLC or MyRunLC files, with 1 = On, and 0 = Off.

Skipped bins filled in by the DAMFileScan program will have the correct Date and Time, but all other columns will be 0, including index, monitor status, and activity channels.

Legacy Channel File

Each Channel File contains the data for a single channel from a single monitor. The file begins with a 4-line header, after which follows the sequential data from the monitor.

Readings with errors (status code not 1) will appear as the negative of the status code, unless the error has been corrected, for example:

File Header:

Line 1	MyRunM001C01 28 Mar 2002	File Name First Date
Line 2	94	Number of Readings
Line 3	30	Reading Interval, MM(SS)
Line 4	1330	First Reading, HHMM(SS)

File Data:

Line 5	0	First Reading
Line 6	3	Activity counts
Line 7	-51	Error status (minus)
Line 8	12	Activity counts
…		
Line nn		Last line of file

Legacy DayLight File

The DayLight file contains the date and time for each reading of the data files. The file begins with the same 4-line header as the channel files, but instead of activity data, the data lines contain the date and time of the reading. Also included on each line are the states of the lights, as reported by the power supply unit at the time of the reading: 0 = Off, 1 = On, 2 = Unknown (Status error from light controller).

Note that these light states are taken immediately prior to any change in them which may be due at the time of the reading, and so indicate the state of the lights over the preceding reading interval.

File Header:

Line 1	MyRunDayLight 28 Mar 2002	File Name First Date
Line 2	94	Number of Readings
Line 3	30	Reading Interval, MM(SS)
Line 4	1330	First Reading, HHMM(SS)

File Data:

Line 5	20020328 1330 100	First Reading
Line 6	20020328 1400 100	Lights = On,Off,Off (1-3)
Line 7	20020328 1430 000	Lights = Off,Off,Off
Line 8	20020328 1500 000	
...		
Line nn		Last line of file

Cables

All cables and wiring accessories are standard items, and should be available locally almost anywhere from a retail computer or electronics supply store. Computer catalog retailers are also good sources for these supplies.

Computer to PSIU USB Cable

The USB cable is of type 'A-B male', and cannot be substituted by another type. Any available length will serve.

Computer to Power Supply Unit (Blue Box) Serial Cable

The Power Supply Unit contains an RS-232 standard DB-25 female connector, which must mate to the cable from the computer. The pinout for the DB-25 is as follows:

Pin 1 = Earth ground

Pin 2 = Transmit to computer

Pin 3 = Receive from computer

Pin 7 = Signal ground

If the computer has a hardware serial port, then the cable to the Power Supply Unit is as follows:

Macintosh (legacy): 8-pin Mini-Din to DB-25 male (Modem)

Windows PC: DB-9 female to DB-25 male (Modem)

If a USB/Serial adapter is to be used, then the USB end will connect to any USB port on the computer. The serial port end will connect to the Power Supply Unit using one of the above cables - usually the PC 'modem' cable (DB-9 female to DB-25 male).

Power Supply Unit to Monitor Cable

The activity monitors are connected to the Power Supply Unit with conventional 4-wire modular telephone cable, and the 6-position RJ-11 connectors are identical to those of domestic telephone 'extension' cables. The same 'normal' or 'straight' wiring polarity is used as the telephone system (opposite color sequence on the 2 ends), so that any telephone wiring accessories or cables which would work at home, will also work to connect activity monitors to the Power Supply Unit.

At least 3 'telephone' jacks are provided on the front of the Power Supply Unit, so a system with 3 or fewer monitors may simply connect each monitor to a jack with a cable. With more than 3 monitors, '5-way splitters' are used, which allow 5 monitors to be connected to a single jack. These in turn may be cascaded in a tree fashion, plugging the cable from one into the next, so that ultimately any number of monitors may be connected to a single Power Supply jack.

For custom cable lengths or wiring configurations, it may be more convenient to make the cables from scratch, and this is readily done. Purchase a roll of 4-conductor flat 'modular' telephone cable, a box of 6-position RJ-11 connectors, and the appropriate hand crimp tool from a retail outlet or catalog. Cut the cable to length, and crimp a connector onto each end, insuring that the color sequence of the 4 wires is reversed between the 2 ends, and that the 4 wires are centered within the 6 positions. Then test the cable.

All monitors, and all Power Supply jacks, are essentially connected in parallel, so any monitor may be plugged into any jack or cable in the network.

Incubator Wiring

If activity monitors are to be used within incubators, it may be convenient to install the 'telephone' wiring permanently within the incubator interior. Attach a 5-way splitter to the side of each shelf with cable ties, and then route 4 short cables from it along the front of the shelf. Secure these cables to the shelf, and leave each with a dangling end, for connection to a monitor.

Then connect the splitters one to the next in daisy-chain fashion using their attached cables, plugging each cable into the unused 5th jack on the next splitter in line. Run the cable from the last splitter out

through a hole in the rear of the incubator, and connect it to the Power Supply using a coupler and extension cable if necessary.

If each incubator is connected to a separate Power Supply jack in this way, the voltage drops in the cables are minimized, and isolation of wiring network problems is more straightforward.

Light Controller to Lights Cable

The Light Controller switches On and Off the AC power outlets on the unit's rear panel. These outlets are the conventional US 117VAC type (NEMA5-15R), and accept a grounded 3-prong plug from a line cord. The other end of this cord must be connected to the lights to be controlled, and will supply up to 3 Amps (fuse limited) at the line voltage. The internal solid-state relays are rated for 240VAC operation, making the unit suitable for line power in most parts of the world.

Troubleshooting

The Drosophila Activity Monitoring System is made up of a number of interconnected components, and the key to efficient troubleshooting is to isolate which component is not performing as it should. The first troubleshooting step should be to verify that the host computer and its DAMSystem software can operate smoothly and continuously over an extended period of time. The Power Supply Unit need not be connected for this test, and if the program halts for any reason, or operates erratically in any way, this part of the system must be diagnosed before reliable data collection can be expected to occur.

Once the program is operating consistently, then the Power Supply Unit may be connected to the computer, and the communication link verified. Then and only then should the monitor network be connected, and finally the monitors themselves.

Computer/Software Errors

Both the Macintosh and Windows platforms should provide reliable operation of the DAMSystem program. If the program either fails at launch, or quits unexpectedly, some condition within the machine has interfered with its ability to execute, and the troubleshooting challenge is to unmask this conflicting condition and then remove it.

Terminate all other applications which may be operating, unplug any network cable, and then reboot the computer. Relaunch the program, and if it still does not run well, transfer it to a similar machine, if available. By comparing its performance in this way, the offending operating system or hardware configuration may be identified and rectified.

USB Driver Problems

If the USB drivers are installed properly, the PSIU should generate no message or error window when it is first connected to a computer USB port. If a message such as 'New Hardware Found' pops up, and does not resolve itself, then the drivers have not loaded properly, and the PSIU has not been recognized. In this case, the drivers should be downloaded from the TriKinetics web site and installed.

If the drivers have already been installed, and they still do not properly recognize the PSIU, then the machine should be rebooted. If connecting the PSIU still generates a New Hardware Found message, the drivers have been corrupted and should be removed and reinstalled (see instructions with downloaded drivers).

Communication Errors

Status codes other than 1 indicate a failure of the computer to successfully acquire data from the addressed monitor. Any break in the communication chain between the DAMSystem program and the hardware monitor will result in such a failure.

If the Status Code is 50 (color black), then the program is unable to communicate with even the PSU/PSIU, and either it is unplugged from the serial port, or its power is off. Check under *Preferences* that the selected communication port is as it should be, and then follow the checkout procedure under Power Supply Interface Unit or Power Supply Unit. Or choose the *Live* (*Monitors*) mode, and watch the status boxes while tracing the connections. Note that a short circuit in the network telephone wiring may prevent any communication, so the first step should always be to disconnect all monitor telephone cables. Then

plug them back in one at a time while watching the status boxes, and in this way track down the offending cable or connection.

If the status code is 51 (color red), then the PSU/PSIU is connected properly, and perhaps other monitors as well, but the monitor in question is somehow disconnected. Plug it into a different network cable until a valid response is received.

Intermittent error codes are always the most difficult to track down. If the error is common to a number of monitors in the same reading, then the problem is likely systemic (wiring or power supply), and not specific to a particular monitor. Try to correlate the time of occurrence with an external disturbance, or some other factor which could cause such a widespread, yet temporary, failure. If, on the other hand, the errors are confined to a single unit, then its connection to the network should be carefully investigated, or simply replaced.

Skipped Readings

Readings which are actually skipped in the collected data (with the red skip error), are due to the inability of the program to collect data at the appropriate time. If, for example, the program is terminated and then relaunched, or the computer goes to sleep for a time, any intervening readings will be skipped. Similarly, if the Reading Interval is set for more readings per hour than can be accomplished by the computer, some will simply be skipped. Reduce the number of monitors, or increase the Reading interval.

Power Outage

A status code of 24 (color yellow) indicates that a monitor performed a power-on reset since its last communication with the computer. This error code supersedes any data output, and indicates that the monitor was inoperative for some or all of the preceding reading interval. If the code is specific to a particular monitor, then its wiring should be examined, as perhaps its connection to the monitor network is intermittent.

If, on the other hand, the 24 code applies to all monitors for a specific reading, then the power for all monitors failed, even if momentarily. Perhaps the PSU/PSIU was inadvertently turned off, or perhaps the monitor cables were unplugged from it for a brief instant.

Sporadic power interruption to the computer and Power Supply Unit may result in significant loss of data if it occurs in the middle of an experiment and goes undetected. A good preventive measure against such loss is a battery-backup Uninterruptible Power Supply (UPS) which can supply line power to the computer and monitor power supply for a short time in the event of an outage. If a backup generator in the lab facility is available to come online within a few minutes, then with such a system no loss of data should occur.

System Reliability

The DAMSystem program, and its attached Power Supply and Activity Monitors, should reliably generate and collect data for hour upon hour without error of any kind. If errors do occur, their cause should be identified and corrected, rather than simply accommodated, so that the system may operate to its full potential. Wiring may fray, and connectors may corrode in high humidity environments, but the overall system is capable of consistent long-term performance, and should be expected to produce it - why settle for less?

Log File

The DAMSystem3 program writes certain status and fault conditions to text file DAMSystem3Log.txt, and these are often useful in diagnosing performance issues. This file is created in the same directory as the DAMSystem3 application.